Fall 2009 Multiple Stressors PI Workshop

Experimental work

2009 Project Overviews and Results

- Quantify internal loading of phosphorus
  - aerobic and anaerobic conditions
  - influence of dreissenid excretion on Phos. loading

- *How do dreissenid mussels affect phosphorus (P) availability?*

- Muck identification and dating

2010 Proposed Projects

- Internal P loading factors (influence of macroalgae)
- How do dreissenid mussels affect phosphorus (P) cont'
- Muck Identification and dating
- Identifying early algal blooms in Sag. Bay (Remote sensing)
- Predicting and managing ***E. coli*** outbreaks
- Identify *Hexagenia* benthic habitats

Internal Phosphorus Loading in Saginaw Bay, Lake Huron

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Ashley Burtner

Objectives:

1) Assess the carbon and nutrient content of the sediments as well as general porosity and bulk density.

2) Quantify internal loading factors of Phosphorus under aerobic and anaerobic conditions

3) Examined the influence of *Dreissena* excretion on sediment nutrient fluxes under aerobic and anaerobic conditions

4) Identify most "hot spots" of P recycling in Saginaw Bay

Sampling sites

Site 5

Sandy, mussel beds;
depth = 11 ft.

Site 10

loose depositional basin;
depth = 38 ft

Site 14

sand-pebble substrate;
depth = 15 ft.

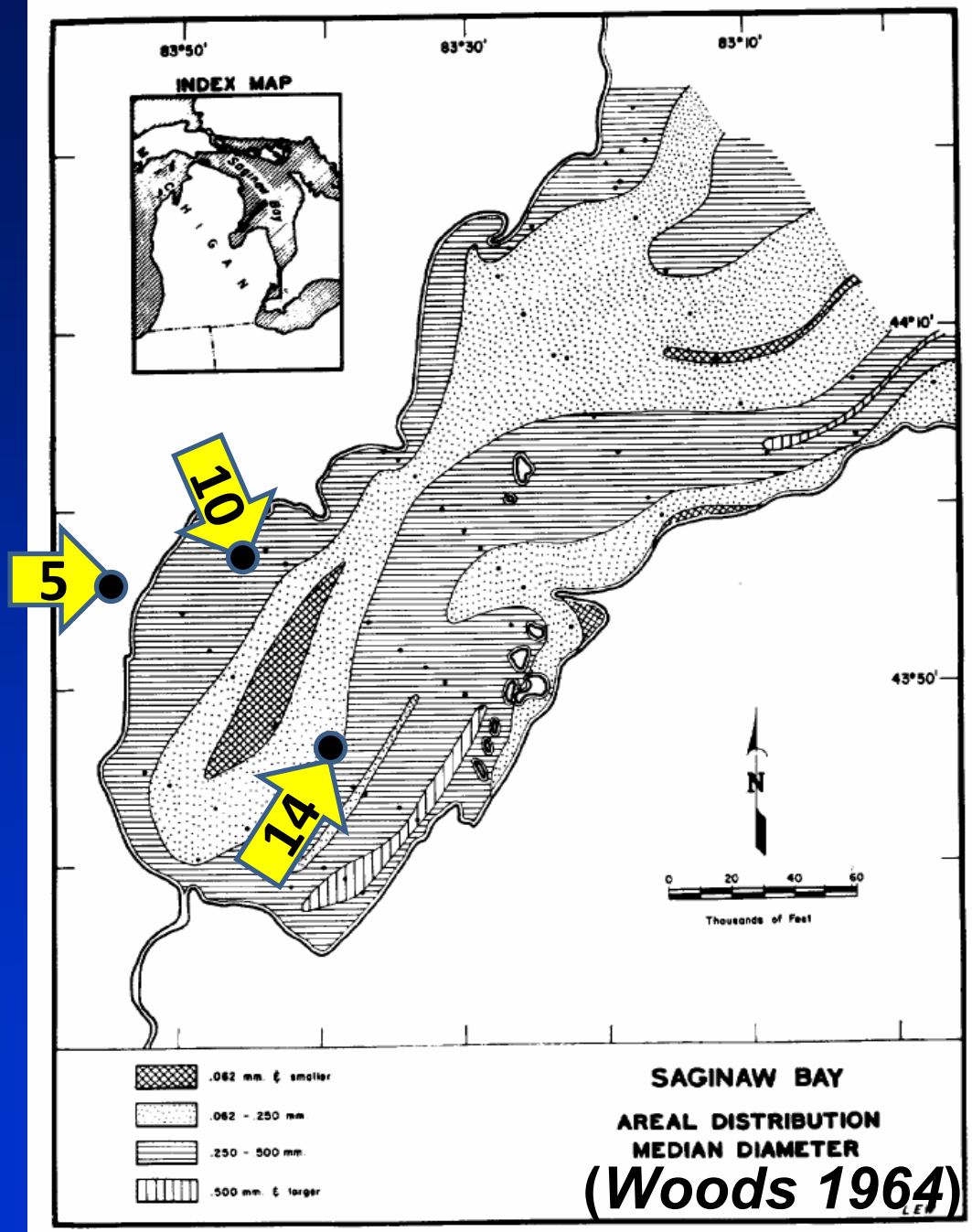
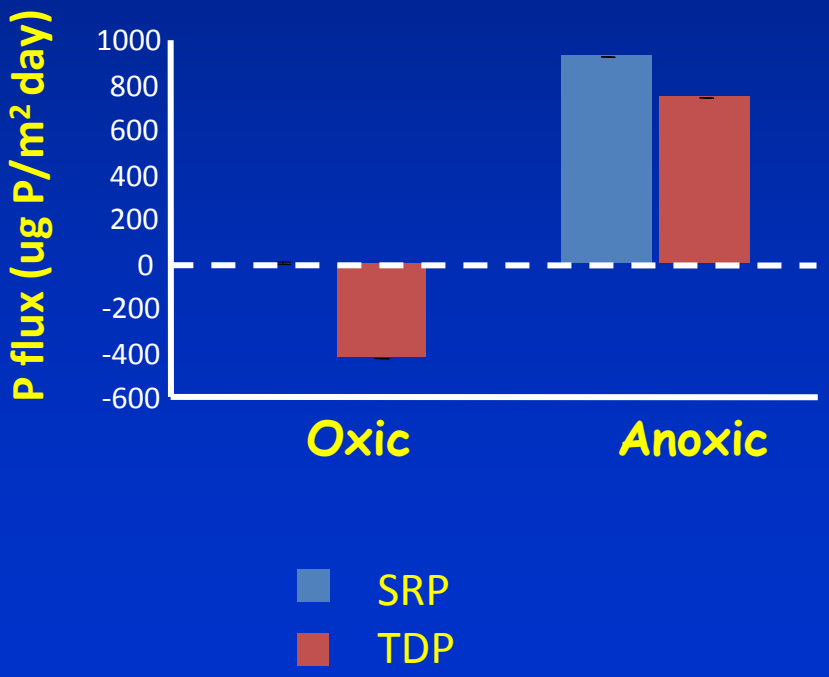


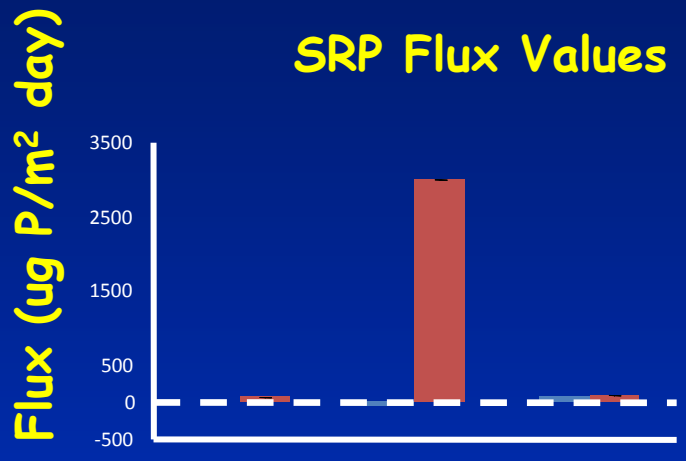
FIG. 4.—Areal distribution of major median-diameter size grades.

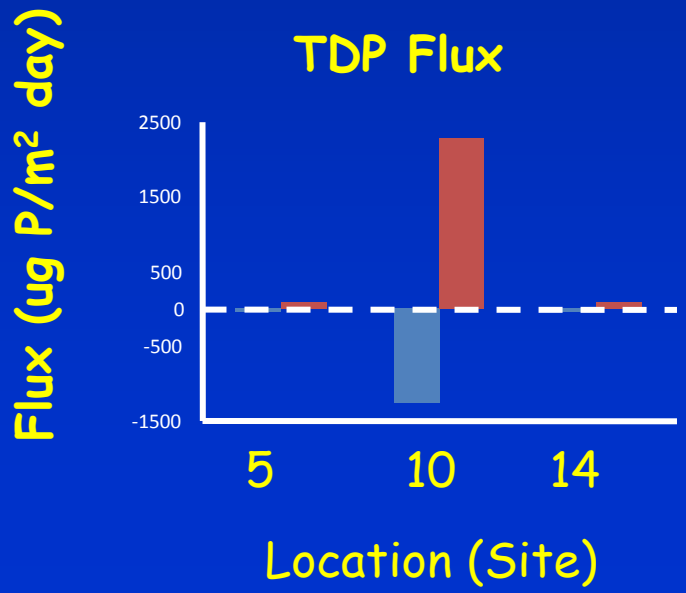
Incubations

- Diver collected cores incubated under ambient temperature and light.
- Aerobic cores bubbled with air.
- Anoxic/Hypoxic cores bubbled with Helium
- Nutrients monitored daily (10 days)

P Fluxes Saginaw Bay



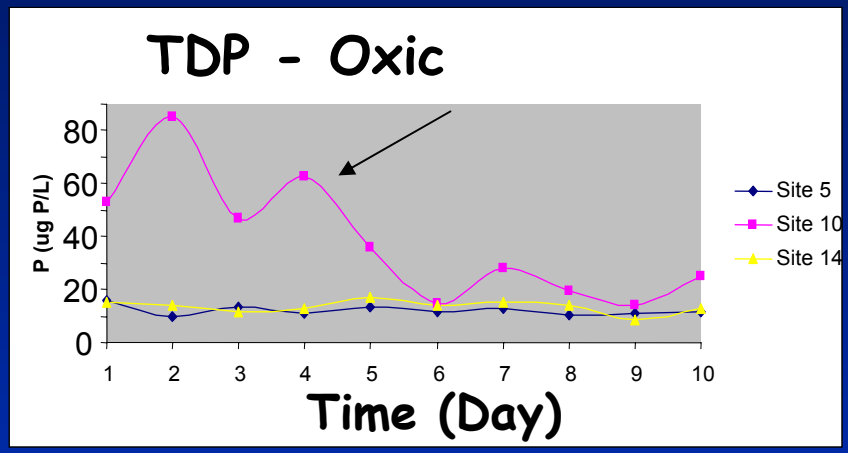


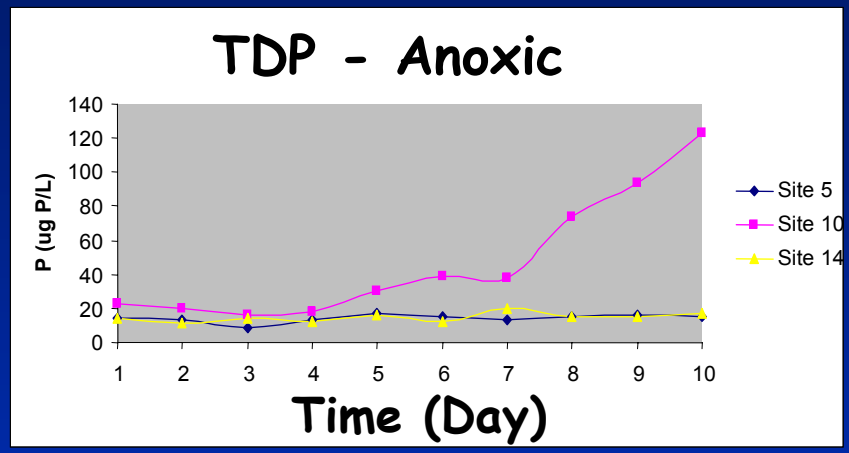


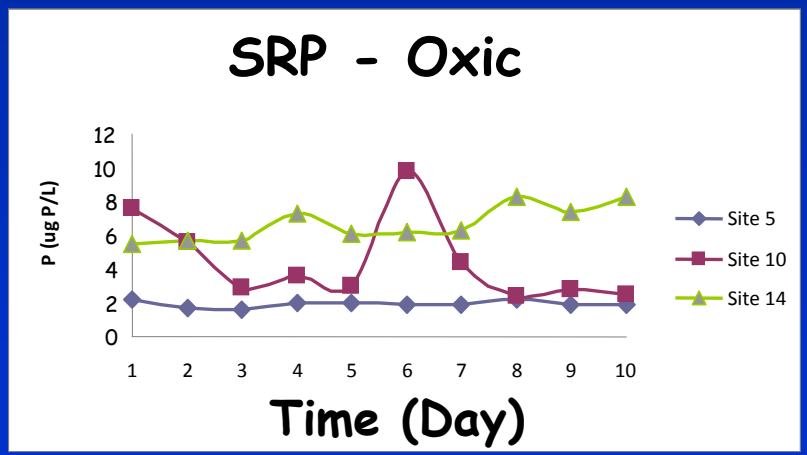
Results Table

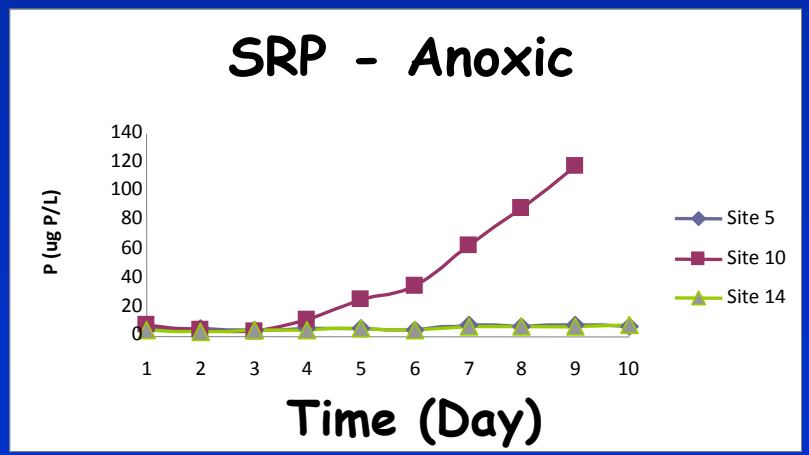
Site	5	10	14
Textural Class	Clay Loam	Clay Loam	Sand
Bulk Density (g/cm^3)	1.66	0.72	1.77
Pore Space (%)	47	72	34
SRP Flux - Oxic (mean)	2.6	-75	61
SRP Flux - Anoxic (mean)	62	3010	86
TDP Flux - Oxic (mean)	-55	-1273	-55
TDP Flux - Anoxic (mean)	84	2267	82

Time Series


TDP - Oxic
P (ug P/L)
0
20
40
60
80
1
2
3
4
5
6
7
8
9
10
Time (Day)
Site 5
Site 10
Site 14


TDP - Anoxic
P (ug P/L)
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8
9
10
Time (Day)
Site 5
Site 10
Site 14


SRP - Oxic
P (ug P/L)
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
9
10
Time (Day)
Site 5
Site 10
Site 14


SRP - Anoxic
P (ug P/L)
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8
9
10
Time (Day)
Site 5
Site 10
Site 14

Conclusion

- Internal loading of P from sediments in Saginaw Bay is correlated with anoxic/hypoxic events.
- Majority of P returning from sediments occurs in sediment type observed at Site 10.
- Prediction and modeling of anoxia in Bay waters may lead to better forecasting of nutrient loads.

Part 2: Effects of dreissenid excretion on P recycling.

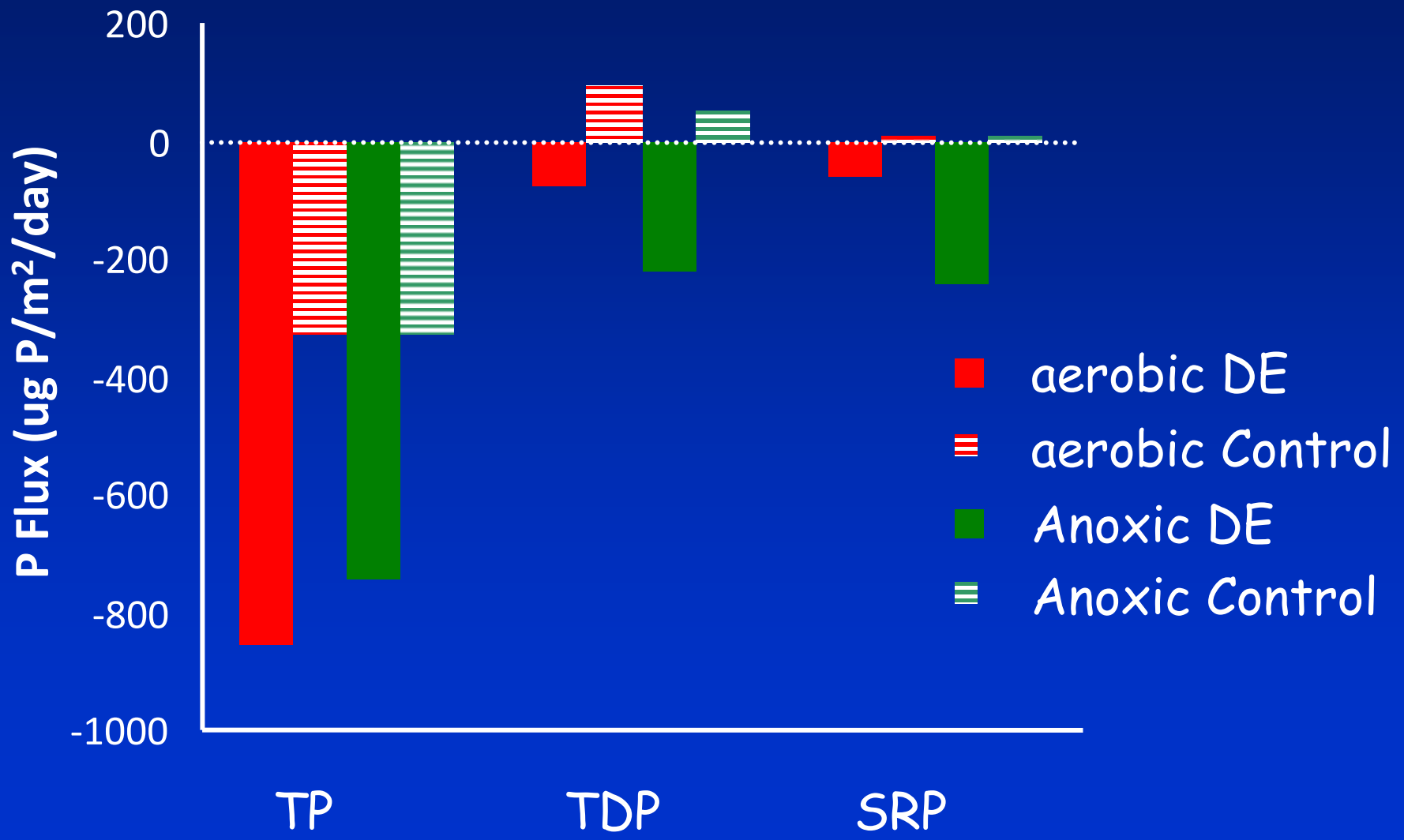
- Cores were collected in same manner as experiment 1
  - site 5 only
  - nutrients monitored daily

- *Dreissena* excretion was collected and applied as a treatment

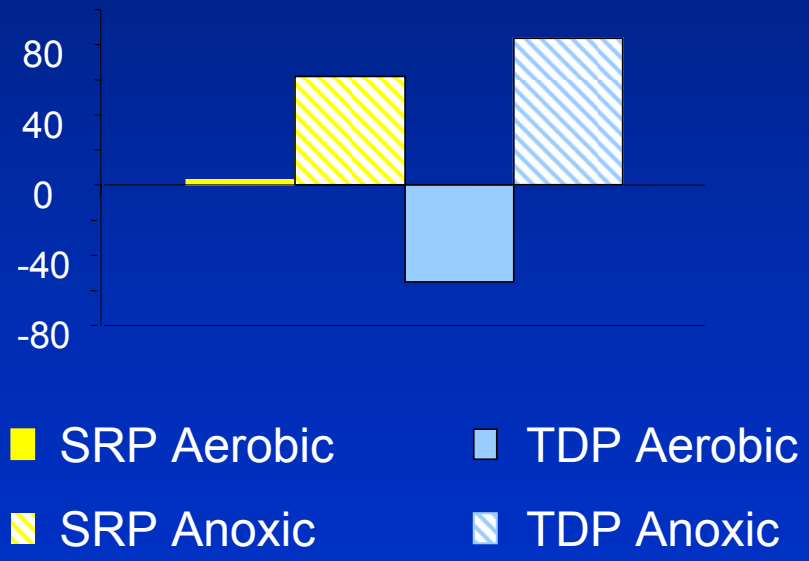
Treatments

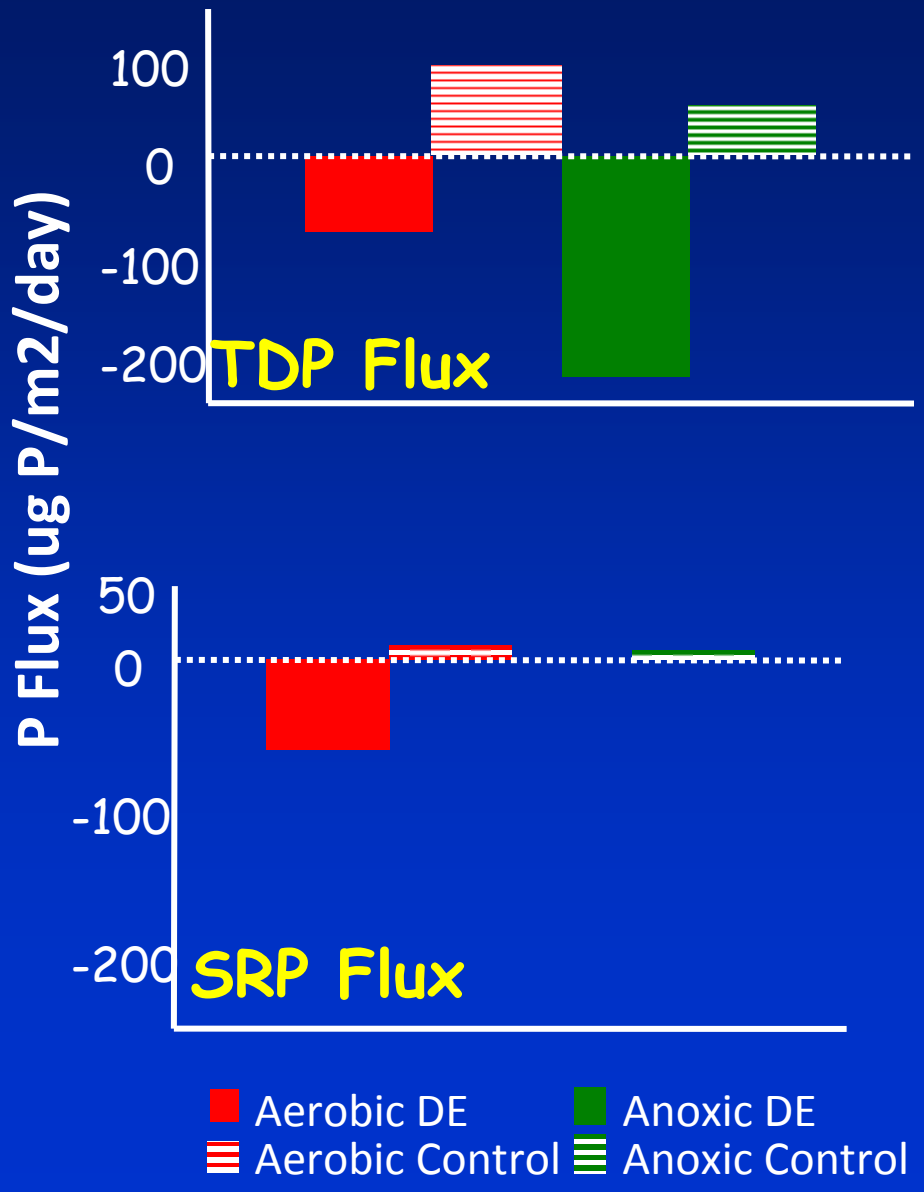
	aerobic	anoxic
+ Dreissena Excretion (DM)	$+O^2$ + DE	$- O^2$ + DE
No inputs	$+ O^2$	$- O^2$

Dreissenid Excretion Impacts



Ex 1:TDP & SRP Fluxes





Mussel mediation of nutrient availability

(Hank, Tom, JoAnn, Jim, Ashley) (Donna and Crew)

How do dreissenid mussels affect phosphorus (P) availability? To answer this question we have established the following goals:

- determine phosphate and ammonia excretion rates by dreissenids as a function of seston composition, feeding rate, and temperature
- estimate the amount of P and N that dreissenids biodeposit each in feces and in pseudofeces as a function of seston composition, feeding rate and temperature
- determine amount of P sequestered by incorporation in dreissenid tissue and shells.
- observe physical binding and breakdown and of feces and pseudofeces in the presence and absence of bay water and sediments.
- evaluate the availability of the P in feces and pseudofeces

ZM Feeding Experiments

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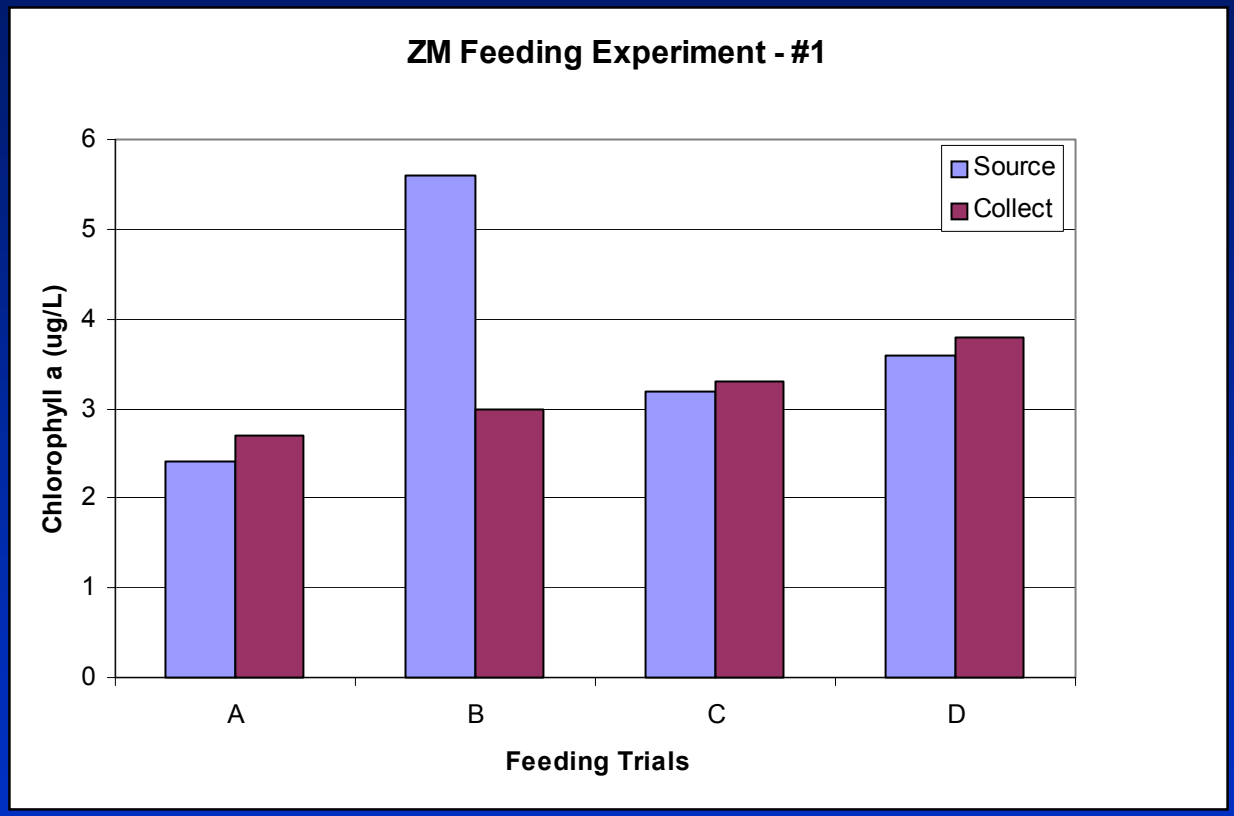
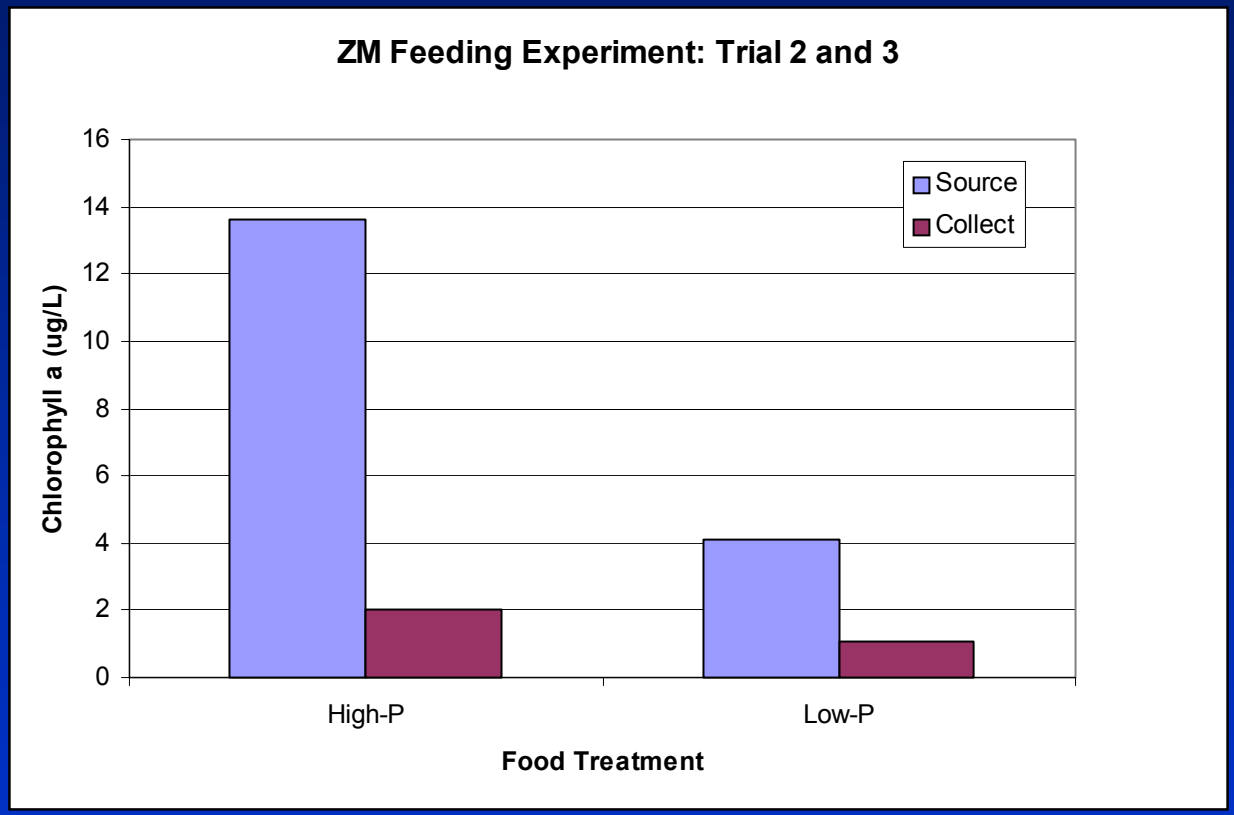


-4 trials
- didn't eat
- no feces produced

<u>Potential Issues</u>
- heat stress
- water source
- food quality
- duration in lab
- prior food acclimation

ZM Feeding Experiments

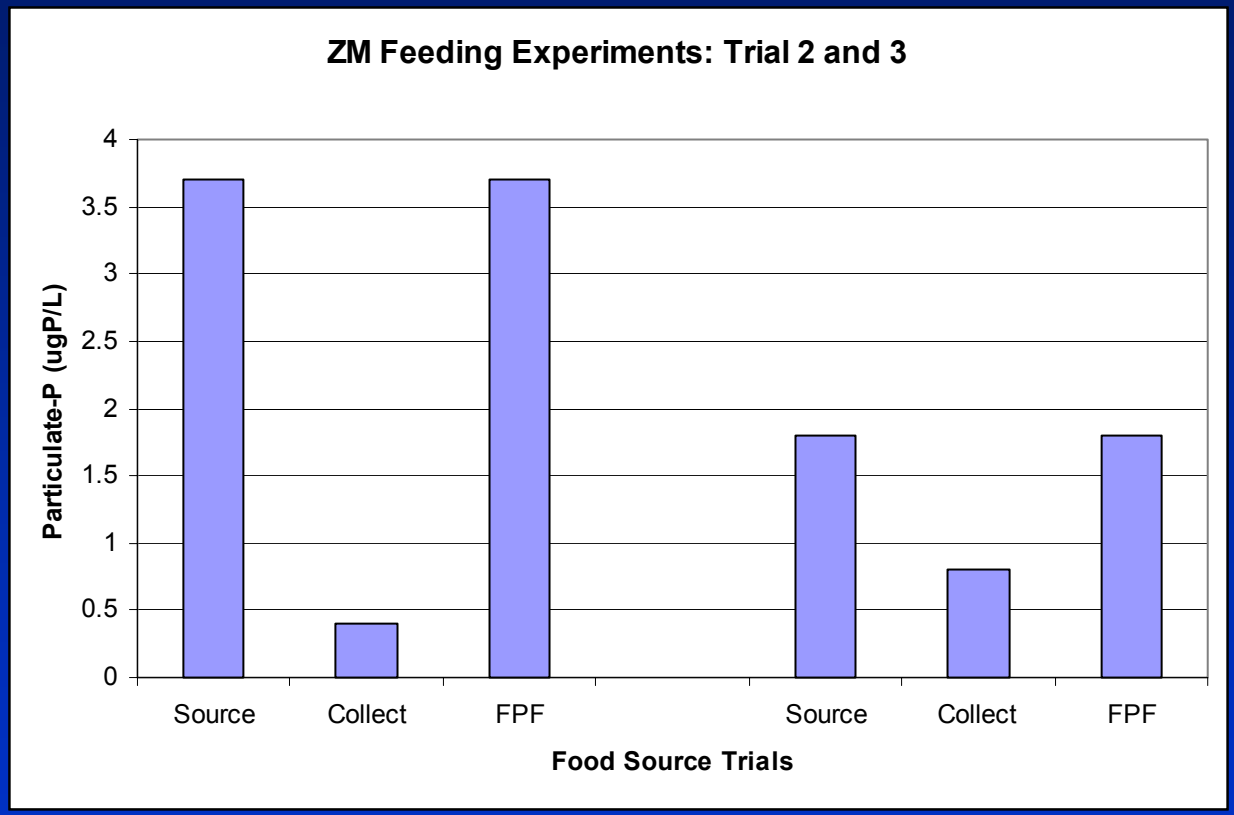


-Experiments in temp control room

- Improved acclimation to test conditions

-Did see uptake and fecal production

ZM Feeding Experiments

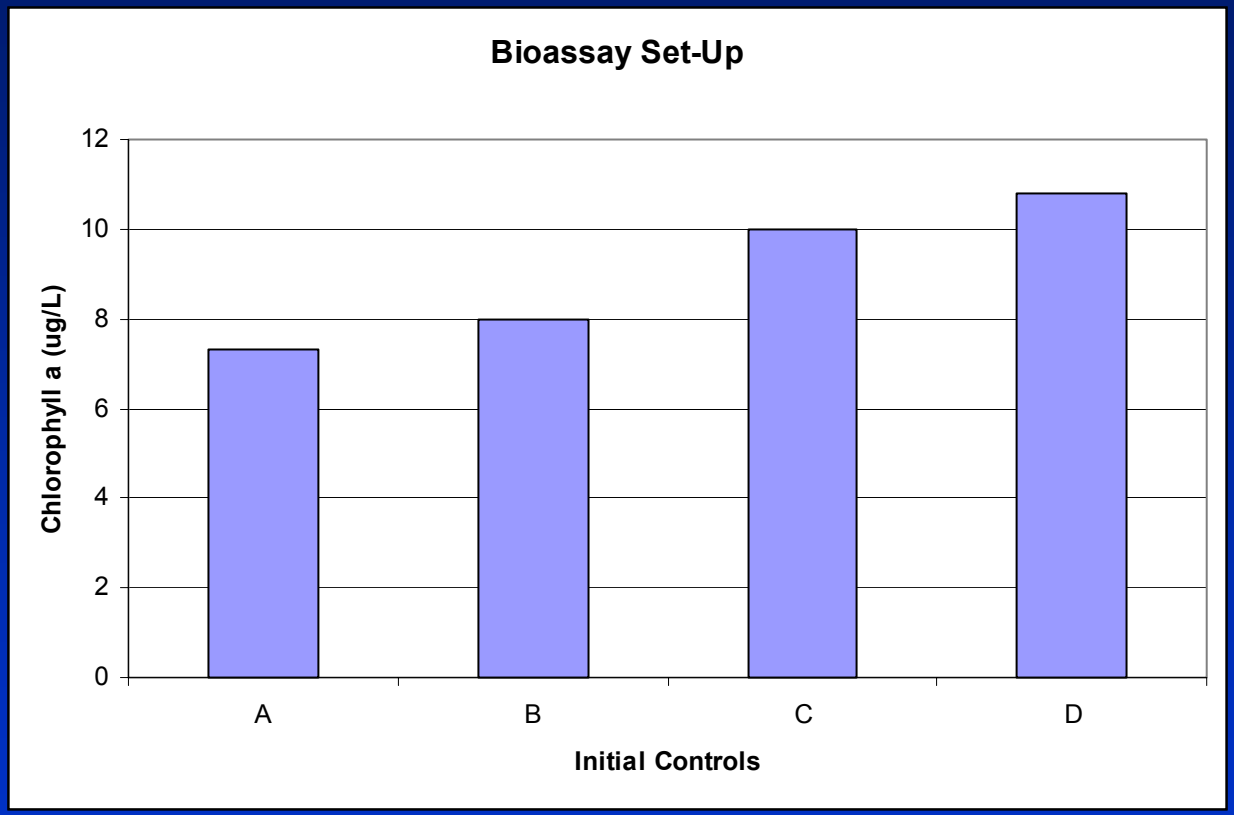


Lower than expected P-content

- media?
- growth phase?
- Harvesting rate?

- Stoichiometric or Quantity???
- Need to modify procedures to produce significant quantities of Feces
- 24 hours of exposure produced only 0.6 ugP to work with

ZM Feeding Experiments



-Variability associated with clumping?

-Need to pre-screen

- 250 mls of NoPN and 10mls of low-P culture

Proposed Activities for 2010

(Hank and Tom)

Jan – Feb: continue lab experiments. Work-out cultures, P-content, and bioassay approach. Work of available-P chemical assay's for riverine material.

Four Sets of Experiments (Mar – May – July – Sept)

- determine phosphate and ammonia excretion rates by dreissenids as a function of seston composition, feeding rate, and temperature
- estimate the amount of P and N that dreissenids biodeposit each in feces and in pseudofeces as a function of seston composition, feeding rate and temperature
- evaluate the availability of the P in feces and pseudofeces
- observe physical binding and breakdown and of feces and pseudofeces in the presence and absence of bay water and sediments.
- evaluate the availability of the P in riverine material (before and after exposure to mussels)

Isotope Investigation

Table 1: Concentrations of ^{210}Pb, ^{7}Be & ^{137}Cs in sediments, muck and trap samples

Sample	^{210}Pb (dpm/g)	^{7}Be (dpm/g)	^{137}Cs (dpm/g)
Bottom Sediments and Muck			
Bottom sediments	2.15±0.27	0.53 ±0.17	.10 ±0.03
Muck -1 (July '09)	0.66 ±0. 19	BD	BD
Muck -2 (July '09)	0.61 ±0. 21	BD	BD
Linwood -Muck (Aug. '09)	0.41 ±0. 20	0.97 ±0.15	0.03 ±0.02
Baycity -Clock -Muck (Aug '09)	10.22 ±0.98	12.25 ±0.89	0.31 ±0.10
Entrance -Muck -1 (Aug. '09)	14.64 ±1.06	4.89 ±0.82	0.23 ±0.08
Entra nce -Muck -2 (Aug. '09)	6.90 ±0 .52	2.89 ±0.41	0.23 ±0.05
Sediment Traps			
Trap -1 (4/29 -?; F3)	29.6 ±0.8	19.4 ±0.6	1.97 ±0.07
Trap -2 (6/18 -7/13) -WCA -2	24.5 ±4.0	31.1 ±4.0	BD
Trap -3 (4/29 -?)	34.8 ±0.8	21.7 ±0.6	2.51 ±0.08
Trap -4 (6/28 -7/13; 10 -20)	2.75 ±1. 03	3.22 ±0.94	BD

BD: below detection limit

What Radioisotopes Tell us?

- The muck samples collected in July 09 were fossil muck (no Be-7, Cs-137 or Pb_{ex}-210 present)
- Muck collected in August had very high concentrations of Be-7, Pb-210 and Cs-137
- We can delineate the old and recent muck based on these nuclides
- The trap studies suggest that the resuspension is very strong and the fluxes of radionuclides are governed by resuspension during June-July months- Linkage between resuspension and muck formation can be established

Uranium Isotopic Study

- Data: U- conc. (ug/L) U-234/U-238 AR

Saginaw River Upstream	1.31	1.14±0.01
Saginaw River	1.09	1.15±0.01
Saginaw Bay	0.53	1.17±0.01
River-mouth	0.63	1.19±0.01

Conclusion

- Distinctly different U concentration and Isotopic ratio in river and Bay waters – source of identification of U and P are possible (geochemically similar elements and hence P sources can be traced using U conc. & activity ratios)

Stable N and Carbon Isotopes

- Data is coming – keep tuned!!!

Proposed Activities for 2010

Kashian et al.

Jan – March: write up for 2009 experiment (anticipated manuscript March 2010).

Field Season: Three Sets of Experiments

- Determine the influence of macro-algae on internal P loading (cladophora, spirogyra, chara)
- Identify hot spots of human specific fecal contamination in the bay using multiple parameters (e.g. *E. coli*, enterococci, Coliphages, *C. perfringens)*
- Determine the spatial distribution of *Hexagenia* nymphs in the Saginaw Bay area, & quantify the population size

2010 Proposed Projects:

#2 Top Management Objective:
Prediction and managing ***E. coli/pathogens*** outbreaks.

Background: The Saginaw Bay Coastal Initiative reported between 11 and 25 beach closures from *E. coli* in Saginaw Bay between 2003 and 2006. The exceedances reported for the beaches in Saginaw Bay resulted between 26 & 106 beach closures or advisories issued.

Goal:

Identify hot spots of human specific fecal contamination in the bay using multiple parameters (i.e. *E. coli*, enterococci, Coliphages, *C. perfringens* and *Bacteroides phages)*

-- monitor near shore waters, muck, and sediment.
-- monitor 3x/year

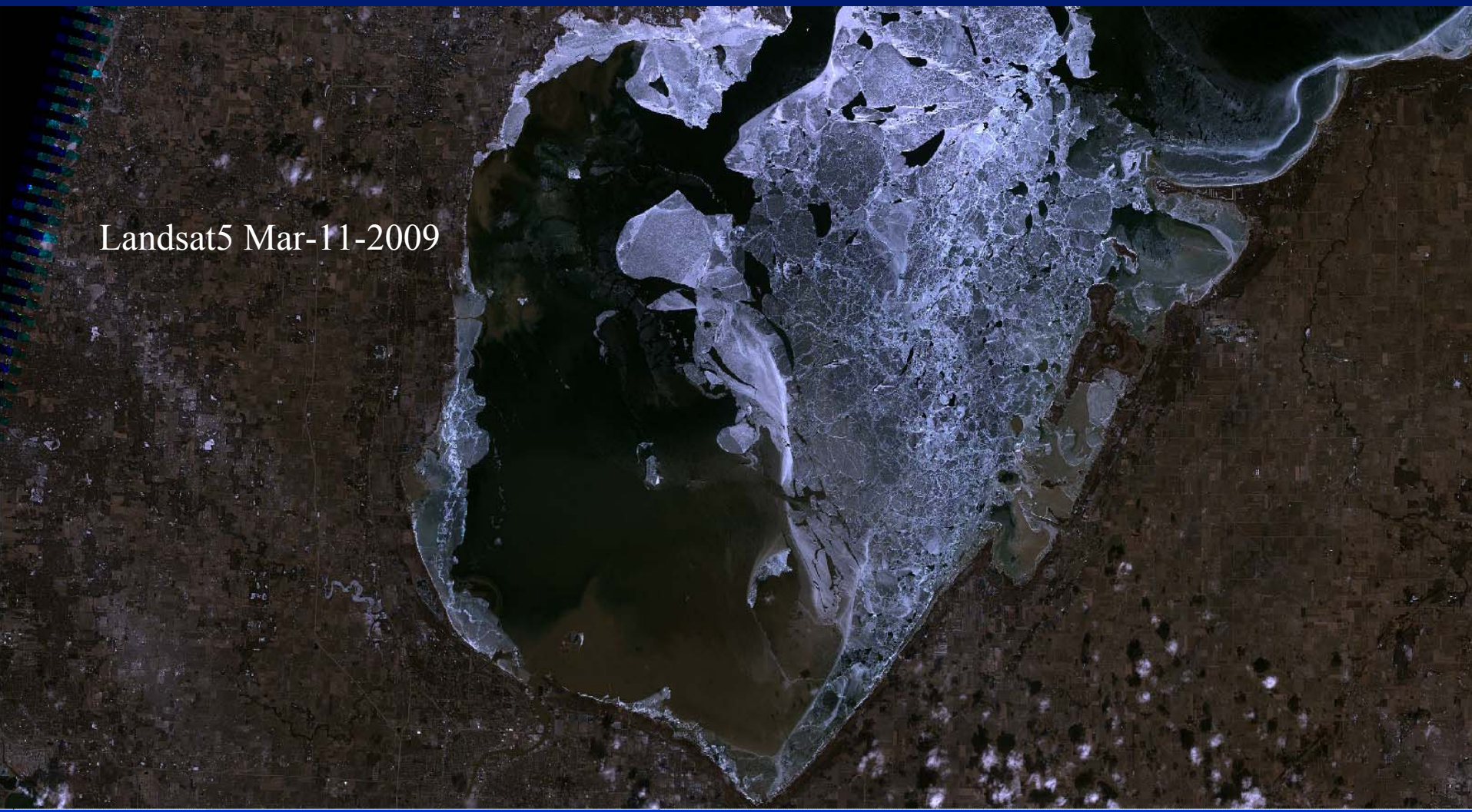
Identify *Hexagenia benthic habitats*

- Determine the spatial distribution of *Hexagenia* nymphs in the Saginaw Bay area, & quantify the population size.
  - Determine optimal environmental locations
  - Check tributaries, near shore and off shore habitats
- Identify environmental conditions that may contribute to a *Hexagenia* return to Saginaw Bay.
- Determine (by size class) how much *Hexagenia* is consumed by walleye and yellow perch in Saginaw Bay.

  -Percent of *Hexagenia* in diet via gut sample analysis

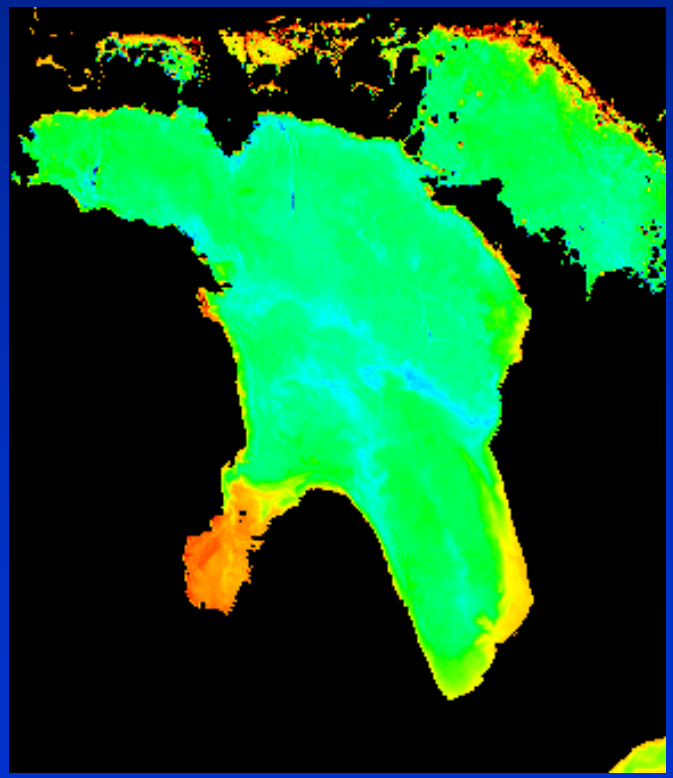
Hexagenia hatch in Au Gres, Michigan, July 2009

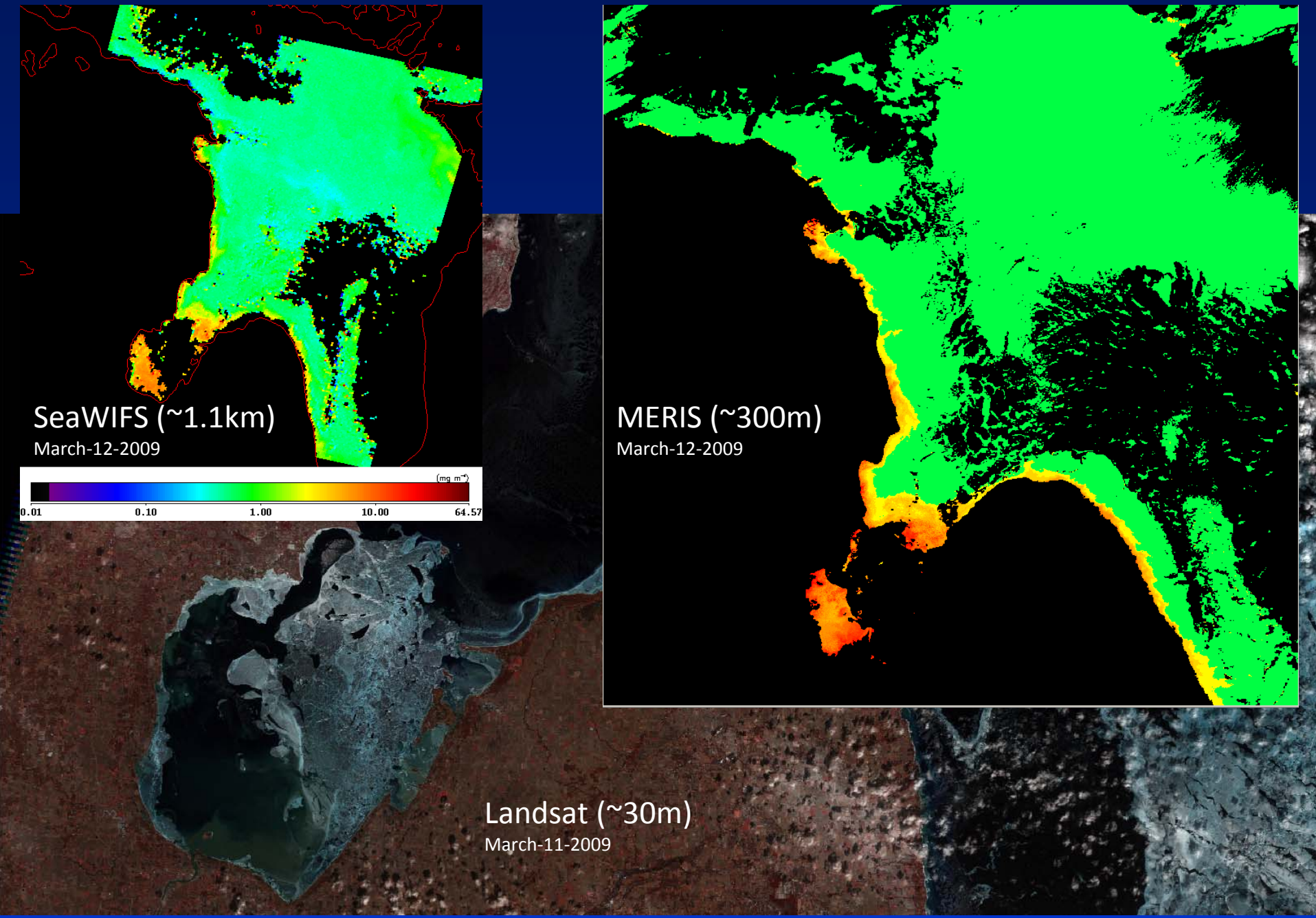
Remote Sensing and Saginaw Bay



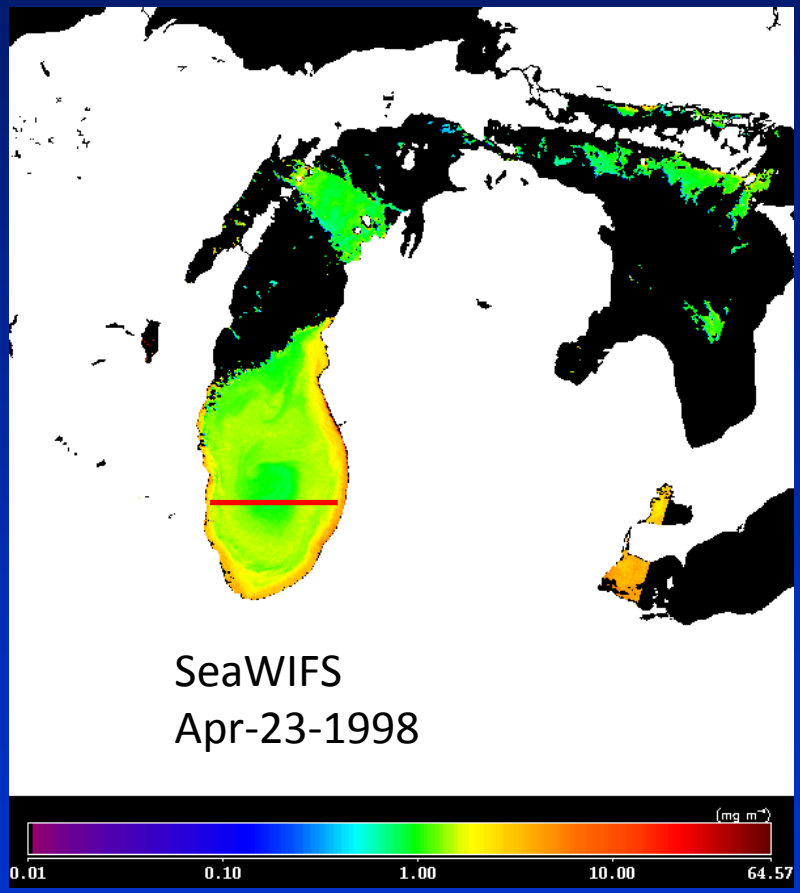
Available Satellites

- Landsat 5 & 7 (every 16days, 30m)
- MERIS (every other day, 300m)
- SeaWIFS!!! (every day, 1.1km)
- MODIS (every day, 1km)

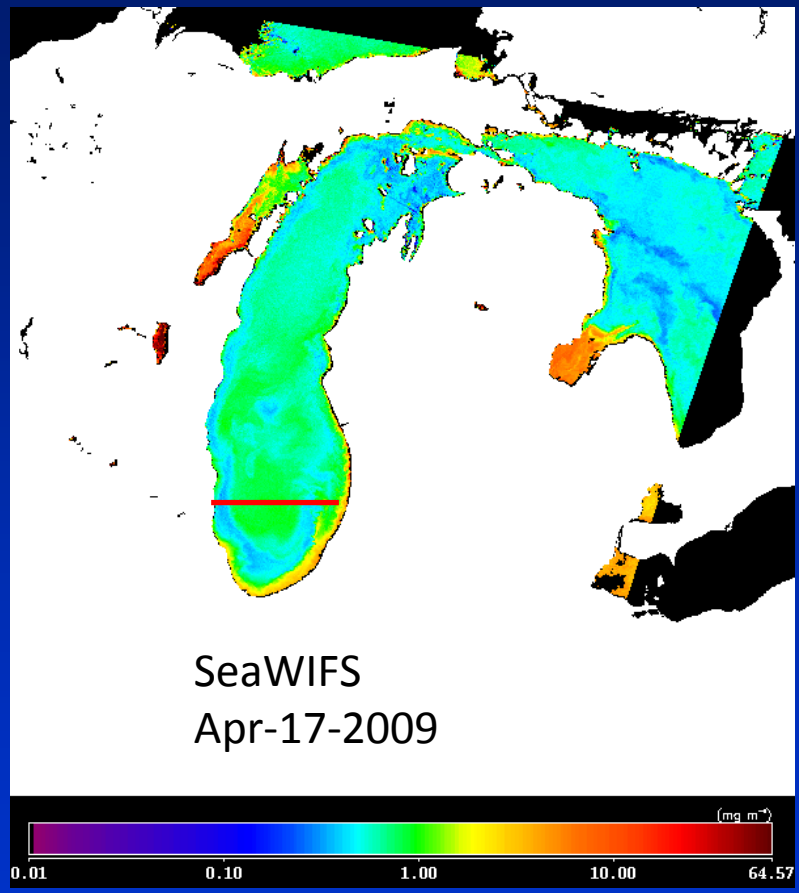



SeaWIFS (~1.1km)
March-12-2009
(mg m⁻³)
0.01
0.10
1.00
10.00
64.57
MERIS (~300m)
March-12-2009
Landsat (~30m)
March-11-2009

Lake Michigan *Chl-a* Time Series Analysis



SeaWIFS
Apr-23-1998



SeaWIFS
Apr-17-2009

Chl-a concentration on fixed locations (Lake Michigan) inside and out side the Doughnut through time

Chl-a concentration from SeaWIFS (Lake Michigan) along the Red transect